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(56) Documents Cited
GB 2174084 A **EP 0208070 A** **AU 970014731 A**

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(54) Abstract Title
Cementitious constructional panels and blocks

(57) Constructional panels or blocks comprise a core made from a mix of
(a) water - 35 - 60 wt% of the total solids with 100 wt parts of solids comprising:
(b) 0.05 - 0.5 % aerating agent, e. g. aluminium powder
(c) 0 - 20 % low density aggregate, e.g. exfoliated vermiculite and / or perlite
(d) 0 - 70 % pozzolanic material, e. g. pulverised fly ash
(e) balance - portland cement, with or without facing sheets on opposite sides.

Facing sheets of fibre cement, gypsum board, cement bonded particle board, or metal may have grooves or rough profiles on their inner faces, the core being cast therebetween.

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LIGHTWEIGHT PREFABRICATED CONSTRUCTIONAL ELEMENT

FIELD OF THE INVENTION :

The present invention relates to improved lightweight prefabrricated constructional elements such as panels and blocks and to a method of manufacture thereof. Though reference is made herein to panels and blocks as the constructional elements, such a reference is only by way of example and not to be construed in a limited manner.

PRIOR ART :

Panel materials are known in the art with core of gypsum having paper facings. These materials, though having reasonably good fire resistant property, have low impact values and limited resistance to water.

It is also known in the art to have panels made of particle board and like materials. However, such panels have limited fire resistance properties.

It is possible to have a panel material with a core using cementicious materials such as cement as binder with commonly used aggregates. However, such panels have a high density. To reduce density of the said composite core, use of lightweight material aggregates such as rice husk and or an expanded polymeric material is also known. Such aggregates though reduce the weight but limit the fire resistant properties and curing system.

OBJECTS OF THIS INVENTION :

It is an object of this invention to propose lightweight prefabricated constructional elements such as panels and blocks that have high strength water resistant, good sound and heat insulation propeties and are cost affection.

It is a further object of the present invention to propose a process for producing lightweight prefabricated constructional elements in-situ with fire resistant lightweight core material between two fire resistant facing sheets.

DESCRIPTION OF THE INVENTION :

According to this invention, there is provided an improved lightweight prefabricated constructional element comprising a composite core prepared from a mix having water 35 to 60% of the total weight of the solids of the core mix mixed with 100 parts of solids comprising 0.05 to 0.5% of an aerating agent such as aluminium powder, 0 to 20% of low density aggregate such as exfoliated vermiculite and/or perlite, 0 to 70% of a pozzolonic material such as pulverised fly ash, the remainder being portland cement, said composite core being with or without facing sheets on opposite sides thereof.

In the instance when the constructional element comprises a block, a facing sheet is not provided on either side of said core. In such as embodiment, the core is prepared from a mix having water 35-60% of the total weight of the solids of the core mix, 0.05 to 0.5% of an aerating agent such as aluminium powder, upto 20% of low density aggregate such as exfoliated vermiculite and/or perlite and optionally upto 70% of a pozzolonic material such as pulverized fly ash, the remainder being portland cement.

In accordance with another embodiment, the constructional element comprises a panel having said core composite aerated between two facing sheets to obtain in-situ bonding resulting in improved lightweight sandwiched panels.

In accordance with yet another embodiment of this invention the constructional element comprises a panel having said core composite aerated between two facing sheets which have grooves/rough surface, on one side of facing sheets which come in contact with core mix to obtain much higher in-situ bonding between core and facing sheets due to higher surface area available for bonding as a result of grooves/rough surfaces provided on said facing sheets.

The presence of exfoliated vermiculate and/or perlite allows the composite core to be cured either by water or high pressure steam. The panels which are subjected to high pressure steam curing attain advantageous properties, such as very low shrinkage.

Pozzolonic material such as pulverised fly ash selected for the composite core has a surface area of 2000 - 6000 cm2/gm.

Anhydrous gypsum used is 0 to 15% of total weight of solids in core mix which facilitate process and improved green strength for handling of precured panels. Lime used is 0 to 20% of total weight of solids in core mix preferably in autoclaved product to balance the reaction with pozzolonic material depending on the chemical composition of the pozzolonic material used.

The construction element such as panel of the present invention are prepared in-situ and have high bond strength between the surface of the core and the facings.

The slurry of said composite core mix with the aerating agents is introduced between the facing sheets which are held rigidly in a jig, aerate, expand due to aeration, thereby generating pressures and effectively fill the pores of the facing sheets to facilitate stronger bonding between the facing sheets and core; the construction elements so manufactured is allowed to set and subjected to curing. The

construction element so prepared has good bond strength between core and facing sheets.

For applications demanding higher bond strength the present invention ensures a much stronger bond and locking action between the core and facing sheets, each of the facing sheet on the inner side are provided with profile such as grooves or random recesses preferably during the process of manufacture of the facing sheets. The slurry of composite core mix with the aerating agents, when introduced in between the said facings held rigidly in the jig, aerate, expand and generate pressure hence effectively fill the grooves or recesses provided apart from the crevicies and pores in the facing sheets; the construction element so manufactured are allowed to set and subjected to curing such construction elements having much higher bond strength due to availability or more surface area and better locking between the profiled facings and core.

Moreover, the aerated composite forming the core of the panel of the invention has improved characteristics such as lightweight, fire and water resistant having good heat insulation properties apart from being cost effective.

Reference is now made to the core composition comprising 0 to 70% of pozzolonic material. The presence of fine silica in Pozzolona allows a reaction with free lime present in

portland cement to produce calcium silicate and minimise leaching of free lime from the panel in due course. The amount of the pozzolonic material added to the core is dependant on the amount of free lime present in the core composition. Preferably, pulverised fly ash is added to the core as the pozzolonic material. A distinct advantage of employing pulverised fly ash as the pozzolonic material is that it is environmentally friendly apart from being cost effective, being a waste product of thermal stations and is available in abundance at negligible costs.

The core contains an aerating material such as aluminium powder. Aluminium powder reacts with lime present in the core composition to liberate hydrogen gas which gets entrapped as air bubles within the core. Such a liberation of gas causes an expansion of the core making the core lighter and aids in better bonding and locking of the facings. Besides aluminium powder, suitable grade of surfacants can be used. Surfactants entrap air bubble in the core mix and make the product lighter.

In the embodiment where the construction element is a panel, the core further comprises 0 to 20% of a low density aggregate such as exfoliated vermiculate and/or perlite. However, in the embodiment where the construction element is a block, the core comprises upto 20% of said low density aggregate.

Moreover aggregates such as exfoliated vermiculite/perlite are more compatible with said cementicious core materials and allow high pressure steam curing apart from conventional water/humid curing whereas known aggregates such as polymer beads are not compatible with said core material and cannot be subjected to high pressure steam curing.

In the instance where the construction element is a panel, the process of the present invention comprises water 35-60% of total weight of the solids of the core mix, mixed with 100 parts of solids comprising 0.05 to 0.5% of an aerating material such as aluminium powder, 0 to 20% of low density aggregate such as exfoliated vermiculite and/or perlite, 0 to 70% of pozzolonic material such as pulverised fly ash, the remainder being portland cement to form a core mix. Slurry of such a core mix is introduced between the facing and allowed to aerate and cure under atmospheric conditions.

In the instance where the construction element is a block and without having any facing on opposite sides of the core, upto 20% of said low density aggregate is present in said core. The thickness of the core and the facings is not a controlling parameter. It depends upon the application of the panel and thus cannot be limited to any thickness or range of thickness. The facings are selected depending on application from particle boards, cement bonded particle

boards and/or metallic sheets and the like with or without grooves/rough profile on one side of facing which comes in contact with core.

The invention is now described hereunder with reference to a preferred exemplary embodiment of the process for manufacture of the light weight prefabricated panel of the present invention which is an illustration and not limitative.

EXAMPLE 1 :

Pulverised fly ash having surface area of 3500 cm2/g 30%, portland cement 59.9% was first mixed alongwith water in an amount of 35% of total weight of solids of the batch mix.

To the mix thus obtained, 10% of exfoliated vermiculate was added as light weight aggregate material followed by the addition of the aerating agent, aluminium powder in an amount of 0.1% mixed with water in an amount of 10% of total weight of solids of the batch mix. The slurry of core mix thus obtained for introduction there between the facings which is discussed hereunder :

The pair of facings which are obtained of fibre cement sheets of 4mm thickness are separated and supported by using conventional jigs and fixtures. The distance between the facing was kept 42 mm to achieve 50 mm thickness panel.

Thereafter, the core mix slurry was introduced between the facings and allowed to aerate and harden for a period of 24 hours.

After the core has hardened, the construction element were separated from the jigs and thereafter subjected to humid curing by conventional technique to obtain panel having the following characteristic features ;

i)	Thickness of panel	50 mm
ii)	Weight	41 Kg/m2
iii)	Fire resistance rating	1 hour BS 476 Parts 20-22 1987
iv)	Surface spread of flame	Class 1 BS 476 Part 7:1989
v)	Water penetration	No evidence of water penetration BS 4315 Part II 1970.
vi)	Linear expansion	2 mm/meter
vii)	Thermal conductivity	0.22 W/M ^{0} K
viii)	Axial load	160 KN/Mtr
ix)	Bond Strength	2.1 Kg/Cm2

EXAMPLE II :

The construction elements were prepared exactly as per example No.I but the Fibre cement facing sheets used were having grooves on one side which comes in contact with the core mix. These grooves are formed during the process of manufacture of facing sheets.

Fibre cement facing sheets of 4 mm thickness with grooves on one side were kept separated and held in Jigs and fixtures, the distance between facing sheets being 42 mm so to produce a panel of 50 mm thickness.

The composition of core mix and the methodology adopted in preparation of panel was same as in example No.I

The physical properties obtained for 50 mm thick panel was as follows :

i)	Thickness of panel	50 mm
ii)	Weight	41 Kg/m2
iii)	Fire resistance rating	1 hour BS 476 Parts 20-22 1987
iv)	Surface spread of flame	Class 1 BS 476 Part 7:1989
v)	Water penetration	No evidence of water penetration BS 4315 Part II 1970.
vi)	Linear expansion	2 mm/meter
vii)	Thermal conductivity	0.22 W/M ^{0} K
viii)	Bond strength	3.0 kg/cm2

Although the above example has been discussed with reference to fibre cement sheet as the facing material, other suitable facing materials can also be used such as gypsum boards, particle boards, cement bonded particle boards, metallic sheets and the like with or without grooves/rough profiles on the side which comes in contact with the core mix.

WE CLAIM :

1) An improved lightweight prefabricated constructional element comprising a composite core prepared from a mix having water 35 - 60% of the total weight of the solids of the core mix mixed with 100 parts of solids comprising 0.05 to 0.5% of an aerating agent such as aluminium powder, 0 to 20% of low density aggregate such as exfoliated vermiculate and/or perlite, 0 to 70% of a pozzolonic material such as pulverised fly ash, the remainder being portland cement said composite core being with or without facing sheets on opposite sides thereof.

2) A constructional element as claimed in claim 1 wherein said composite core is prepared from a mix having water 35-60% of the totalweight of the solids of the core mix, mixed with 100 parts ofsolids comprising 0.05 to 0.5% of an aerating agent such as aluminium powder, upto 30% oflow density aggregate such as exfoliated vermiculite and/or parlite and optionally upto 70% of a pozzolonic material such as pulverized ash, the remainder being portland cement.

3) A constructional element as claimed in claim 1 wherein said facing sheets are plain.

4) A constructional element as claimed in claim 1 wherein said facing sheets have grooves/rough profiles on the inner surface thereof so as to increase the surface area and improve locking and bonding between the core and said facings.

5) A constructional element as claimed in claims 3 and 4 wherein said facing sheets are fibre cement sheets, gypsum boards, particle boards, cement bonded particle boards, metallic sheets and the like.

6) A constructional element as claimed in claim 1 to 2 having anhydrous gypsum present in an amount of 0 to 15% in said composite core mix.

7) A constructional element as claimed in claims 1 to 2 having lime present in an amount of 0 to 20% in said composite core mix.

8) A constructional element as claimed in claim 1 and 2 wherein said aerating agent is aluminium powder used singularly or in combination with any other known air entraining agent, such as surfactants.

9) A constructional element as claimed in claim 1 and 2 wherein said pozzolonic material is pulverised fly ash having a surface area preferably 2000-6000 cm2/gm.

10) A process for the manufacture of an improved lightweight prefabricated constructional element comprising the steps of preparing a core from a water based slurry having water 35-60% of the total weight of the solids of the core mix mixed with 100 parts of solids comprising 0.05 to 0.5% of an aerating agent such as aluminium powder, 0 to 20% of low density aggregate such as exfoliated vermiculite and/or perlite. 0 to 70% of a pozzolonic material such as pulverised fly ash, the remainder being portland cement, allowing said core mix to aerate and cure as such or between a facing on opposite sides of said core.

11) A process as claimed in claim 10 wherein said composite core is prepared from a mix having water 35-60% of the total weight of the solids of the core mix, mixed with 100 parts of solids comprising 0.05 to 0.5% of an aerating agent such as aluminium powder, upto 20% of low density aggregate such as exfoliated vermiculite and/or perlite and optionally upto 70% of a pozzolonic material such as pulverised ash, the remainder being portland cement, allowing said core mix to aerate and cure.

12) A process as claimed in claim 10 wherein said composite core mix is introduced in between said pair of facing sheets held rigidly in Jigs allowed to aerate, and expand due to such aeration, and thereby cause generate pressures to effectively fill the pores of said facing sheets,

facilitating locking between said facing sheets and core, and then allowed to set and subject it to curing, said construction element so prepared have good bond strength between core and facing sheets.

13) A process as claimed in claim 10 wherein said composite core mix is introduced, between said pair of facing sheets held rigidly in jigs and having grooves/rough profile which are preferably obtained during the process of manufacture on one side of the facing sheets which come in contact with said core mix allowing said core mix to aerate expand due to such aeration and there by cause a generation of pressure to effectively file the pores crevices/ grooves, of said facing sheets, facilitating effective locking of said facing sheets with core due to availablity of higher surface area of contact between core and said facing sheets, and then allowed to set and cure, such construction elements having higher bond strength between said core and facing sheets.

14) A process as claimed in claim 10 to 12 wherein said aerating agent is aluminium powder used singularly or in combination with any other known air entraining agent. such as surfactants.

15) A process as claimed in claims 10 to 14 wherein anhydrous gypsum is present in an amount of 0 to 15% in said core.

16) A process as claimed in claims 10 to 15 wherein lime is present in an amount of 0 to 20% in said core.

17) A process as claimed in claims 10 to 15 wherein pozzolonic material such as pulverised fly ash has surface area preferably 2000-6000 cm2/gm.

18) A process as claimed in anyone of claims 10 to 13 wherein the step of curing comprises water/humid curing or high pressure steam.

19) A process as claimed in claim 10 wherein said facing material is selected, from fibre cement sheet, gypsum, boards, particle boards, cement bonded particle boards and/or metallic sheets and the like.

20) A lightweight prefabricated constructional element substantially as described herein.

21) A process for the manufacture of a lightweight prefabricated constructional element substantially as described herein.

The Patent Office

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Application No: GB 9707151.8 **Examiner:** J D Cantrell
Claims searched: 1 - 21 **Date of search:** 8 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1D: DCF, DCH CIH : HCA, HXL

Int Cl (Ed.6): E04C C04B

Other: ON-LINE: WPIL

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,E	AU 9714731 A	BTA PTY LTD	All
A	GB 2174084 A	JONG	-
A	EP 0208070 A	RHEINISCH &c	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.